of tellurium and 0.02 to 0.4 percent, by weight, of selenium in addition to the components of the eighth invention alloy. While a high-temperature oxidation resistance as good as in the eighth invention alloy is secured, the machinability is further improved by adding one element selected from among bismuth and other elements which are as effective as lead in raising the machinability,

[0042] A free-cutting copper alloy also with excellent easy-to-cut feature and a good high-temperature oxidation resistance which is composed of 69 to 79 percent, by weight, of copper; 2.0 to 4.0 percent, by weight, of silicon; 0.02 to 0.4 percent, by weight, of lead; 0.1 to 1.5 percent, by weight, of aluminum; 0.02 to 0.25 percent, by weight, of phosphorus; at least one selected from among 0.02 to 0.4 percent, by weight, of chromium and 0.02 to 0.4 percent, by weight, of titanium; and the remaining percent, by weight, of zinc, wherein the percent by weight of copper, silicon, aluminum, phosphorous and chromium in the copper alloy satisfy the relationship $60 \leq X - 3Y + aZ + bW + cV \leq 70$, wherein X is the percent, by weight, of copper, Y is the percent, by weight, of silicon, Z is the percent, by weight, of aluminum, W is the percent, by weight, of phosphorous, V is the percent, by weight, of chromium, a is –2, b is –3, and c is 2; and the copper alloy has a metal construction comprising multiple phases integrated to form a composite phase, wherein the composite phase is an α phase matrix having a total phase area comprising not more than 5% of a β phase, and 5-70% of the total phase area is provided by at least one phase selected from the group consisting of a γ phase, a κ phase, and a μ phase. The tenth copper alloy will be hereinafter called the "tenth invention alloy."

[0043] Chromium and titanium are intended for improving the high-temperature oxidation resistance of the alloy. Good results can be expected especially when they are added together with aluminum to

produce a synergistic effect. Those effects are exhibited when the addition is no less than 0.02 percent by weight, whether they are added alone or in combination. The saturation point is 0.4 percent by weight. For consideration of such observations, the tenth invention alloy has at least one element selected from among 0.02 to 0.4 percent by weight of chromium and 0.02 to 0.4 percent by weight of titanium in addition to the components of the eighth invention alloy and thus further improved over the eighth invention alloy with regard to high-temperature oxidation resistance.

[0044] A free-cutting copper alloy also with excellent easy-to-cut feature and a good high-temperature oxidation resistance which is composed of 69 to 79 percent, by weight, of copper; 2.0 to 4.0 percent, by weight, of silicon; 0.02 to 0.4 percent, by weight, of lead; 0.1 to 1.5 percent, by weight, of aluminum; 0.02 to 0.25 percent, by weight, of phosphorus; at least one element selected from among 0.02 to 0.4 percent, by weight, of chromium and 0.02 to 0.4 percent, by weight, of titanium; one element selected from among 0.02 to 0.4 percent, by weight, of bismuth, 0.02 to 0.4 percent, by weight, of tellurium and 0.02 to 0.4 percent, by weight, of selenium; and the remaining percent, by weight, of zinc, wherein the percent by weight of copper, silicon, aluminum, phosphorous and chromium in the copper alloy satisfy the relationship $60 \leq X - 3Y + aZ + bW + cV \leq 70$, wherein X is the percent, by weight, of copper, Y is the percent, by weight, of silicon, Z is the percent, by weight, of aluminum, W is the percent, by weight, of phosphorous, V is the percent, by weight, of chromium, a is –2, b is –3, and c is 2; and the copper alloy has a metal construction comprising multiple phases integrated to form a composite phase, wherein the composite phase is an α phase matrix having a total phase area comprising not more than 5% of a β phase, and 5-70% of the total phase area is provided by at least one phase selected from the

group consisting of a γ phase, a κ phase, and a μ phase. The eleventh copper alloy will be hereinafter called the "eleventh invention alloy."

[0045] The eleventh invention alloy contains any one element selected from among 0.02 to 0.4 percent, by weight, of bismuth, 0.02 to 0.4 percent, by weight, of tellurium, and 0.02 to 0.4 percent, by weight, of selenium, in addition to the components of the tenth invention alloy. While as high a high-temperature oxidation resistance as in the tenth invention alloy is secured, the eleventh invention alloy is further improved in machinability by adding one element selected from among bismuth and these other elements, which are as effective as lead in improving machinability.

[0046] A free-cutting copper alloy with further improved easy-to-cut properties, obtained by subjecting any one of the preceding respective invention alloys to a heat treatment for 30 minutes to 5 hours at 400 to 600°C. The twelfth copper alloy will be hereinafter called the "twelfth invention alloy."

[0047] The first to eleventh invention alloys contain machinability improving elements such as silicon and have an excellent machinability because of the addition of such elements. The effect of those machinability improving elements could be further enhanced by heat treatment. For example, the first to eleventh invention alloys which are high in copper content with gamma phase in small quantities and kappa phase in large quantities undergo a change in phase from the kappa phase to the gamma phase in a heat treatment. As a result, the gamma phase is finely dispersed and precipitated, and the machinability is improved. In the manufacturing process of castings, expanded metals and hot forgings in practice, the materials are often force-air-cooled or water cooled depending on the forging conditions, productivity after hot working (hot extrusion, hot forging, etc.), working environment, and other factors. In